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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1165

Washington, D. C. July 20, 1923

REPORT ON BIRD CENSUSES IN THE UNITED STATES 1916 TO 1920

By

MAY THACHER COOKE, Assistant in Biological Investigations
Bureau of Biological Survey

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INTRODUCTION.

Definite information regarding the number, distribution, and relative abundance of the breeding birds of the United States is greatly desired. The Biological Survey started an inquiry for this purpose in the spring of 1914 and sent out circulars to many interested persons throughout the country requesting their assistance. In addition to the importance of the information desired, because of the value of birds to agriculture, exact knowledge regarding the abundance and distribution of birds was needed in formulating regulations for the protection of game and other migratory birds, the Congress having recently passed laws placing them in charge of the Department of Agriculture. It was also important to ascertain what effect the laws then in force had already had on the bird life of the country.

The preliminary survey in 1914 proved so satisfactory that the work was repeated the next year on a somewhat larger scale. The results of the work in 1914[1] and 1915[2] revealed something of the possibilities of this method of study—that it was a practicable means of obtaining much important and valuable information, and that thereafter it should be a permanent part of the work of the Biological Survey. As there are no funds available for this kind of work, it depends entirely on the cooperation of volunteer observers.

[1] Bull. 187, U. S. Dept. Agr., Preliminary census of the birds of the United States. 1915.
[2] Bull. 396, U. S. Dept. Agr., Second annual report of bird counts in the United States, with discussion of results. 1916.

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The work has been continued, but unfortunately on a smaller rather than a larger scale. During the war many persons were unable to make the necessary surveys and some lost interest because of the impossibility of publishing the results obtained. The returns for 1919 were so few as to be of value for purposes of comparison only, in those cases where the areas dealt with were previously, or subsequently, reported upon. A gratifying increase in interest and in the number of returns was shown in 1920.

For these seven years the bird censuses taken in the part of the country north of Maryland and east of Kansas have been sufficient in number to allow some generalizations as to the average bird population, but many more are needed from the Southern and Western States before it will be possible to draw any conclusions as to the bird life of these sections.

The counts of 1914 and 1915 showed slightly over one pair of birds to the acre on the farm land of the northeastern section above mentioned, or approximately 800 pairs to the square mile. For the five years 1916 to 1920, inclusive, there are fewer reports than for the two earlier years, but the averages obtained agree fairly well with those previously published, so that it seems probable that the figures above stated are reliable. As yet nothing can be said about the numbers of the individual species, and only tentative statements are possible regarding the relative abundance of a few of the most common species.

Many problems concerning bird life can be solved by no other means than by bird censuses; that some can be solved, in part at least, by this work has already been proved, but many have not yet even been touched upon. How many birds per acre breed in the different parts of the country, in the permanent marshes, and in the forested regions of New England, the eastern mountains, and the Rockies? What is the relative abundance of the different species in the country as a whole and in the different life zones, and how are they distributed? Where are the centers of abundance for birds generally and for the several species? Are birds most abundant where they are most needed, about the farms, gardens, and orchards? How do altitude and latitude affect the numerical distribution of birds? What effect on bird life has the presence of water, as a small stream or a river, a pond or a lake? What fluctuations take place in bird life from year to year, or over longer periods? When protection and encouragement bring about an increase in the number of birds nesting on a given tract, are there actually more birds in the locality, or is this increase due to a concentration of the birds from a larger area for nesting purposes? How do birds respond to changes in such environmental conditions as more intensive cultivation, changes in crops, or the clearing of woodland? How is irrigation affecting the bird life of the arid lands of the West? What changes will occur there in numbers and species, and how rapidly will they take place? How much have birds increased under protection? Are the present Federal and State laws adequate? What changes, if any, are taking place in the numbers and relative abundance of the several species?

That the counts might be made in a uniform way and thus provide data which could be used in comparisons and in deducing the desired information, each observer was given instructions regarding

the selection of the area to be covered, the time at which to make the count, and the information to be included in the report. As a knowledge of methods followed is essential to an understanding of how the conclusions here presented were reached, it will be well to outline what are considered the best conditions and procedure in taking a bird census. In the following discussion the experience gained from the actual work is embodied with the early plans and instructions.

METHODS OF TAKING BIRD CENSUSES.

It is obviously impossible to enumerate all the birds in the country or even in a small section, but the birds nesting on a tract of not over 80 acres can be counted by one observer with considerable exactness. The combined results of many such counts will furnish a key to conditions in the country as a whole. The sample tracts should represent as nearly as possible the average conditions for their respective localities in regard to the proportions of woods, orchards, crops, pasture, etc. It is, of course, impossible to find one tract that contains all of these elements in exactly the right proportions, but the greater the number of tracts surveyed, the less will be the chance of error in the resulting averages.

The plots of farm land chosen for the censuses should contain on the average from 40 to 80 acres. A tract of less than 40 acres seldom shows sufficient diversification to be representative; and an 80-acre tract is as large as one person can accurately cover under most circumstances. When the enumerator lives on or near the land surveyed and has the time to devote to the work, larger areas can be and have been very satisfactorily worked.

Sometimes because of local conditions it is desirable to have a census over a large area. In such cases, especially if the tract shows considerable diversity, the work is facilitated and the interest and value increased by dividing it into two or more sections and treating each as a separate count, thus indicating how the birds are distributed. Contiguity of the tracts surveyed adds materially to the interest and value of each, since not only is a larger area thereby represented, but something of local distribution is shown. Two series of counts from Kansas, elsewhere quoted somewhat at length, are excellent examples of this (pp. 11–12).

It has been deemed important that, so far as possible, areas be selected on which conditions are not likely to change for several years. Under such circumstances it will then be evident that fluctuations in the bird life on these areas are not due to artificially changed environment. Nevertheless, counts of all kinds are welcomed, for it is impossible to have too many; moreover, the response of birds to changes in environment is an interesting study in itself.

It is very important that counts be made on the same areas year after year, in order that the records may give some basis for comparisons. Only by the accumulation of large series of records dealing with the same land can definite conclusions be drawn as to average conditions or as to changes taking place—whether birds generally or individual species are increasing or decreasing. A study of the conditions that existed in the eastern United States in 1918 (see pp. 28–31) has shown the value of such series of records as a means of studying fluctuations in bird life.

The Biological Survey has advocated counting the singing males as the most convenient way of taking a bird census, and this method has given excellent results. The observer starts at daylight some morning at the height of the breeding season and zigzags back and forth across the selected tract, counting the singing birds. At that season, when the migration is over and the birds are settled on their breeding grounds, each male bird may be safely considered to represent a nesting pair, and early in the morning, before the insects are flying and the birds begin feeding, the male is usually to be found in the vicinity of the nest. The count should be repeated once or twice at intervals of a few days to be sure that no birds have been missed and that all the birds counted are actually nesting on the area.

If the enumerator lives close by, one day's count may be checked by subsequent observations throughout the breeding season. Whenever possible, it is well to go over the land again late in the season to catch any late nesting species, such as goldfinches and waxwings. To locate every nest is not necessary; unless the enumerator lives on or very near the tract it is practically impossible to do so, and the time required in any case is enormous. Experience has shown that a count of 50 acres can be made in three hours by the method outlined and that subsequent observations throughout the summer make almost no change. However, in the case of unusual species and especially those outside their known breeding range, it is insisted upon that the nest be located or other satisfactory evidence found as proof that the birds were actually breeding in the locality and were not merely wanderers or delayed migrants.

ESSENTIALS OF A SATISFACTORY BIRD CENSUS.

The observer must be thoroughly familiar with the birds breeding in his locality, both by sight and song, in order that all the birds found nesting on the selected area may be positively identified, or a recognizable description given of such as can not be readily named. Otherwise some species may be omitted and the report be not usable since it does not tell the whole truth.

For a number of years the Biological Survey has been receiving each year from several hundred volunteer observers throughout the country reports on the arrival and departure of birds during the spring and fall migrations. Some of these observers are well acquainted with the birds, while others know only a few; in the case of the latter, however, if their knowledge is accurate regarding the few they do know, and if they are well situated to watch the birds and note their first arrival, the fact that they do not know all the species in no way detracts from the value of their records for the arrivals and departures of the species noted. In making a bird count, however, such partial knowledge is worse than useless, and some reports, doubtless entirely correct for the species listed, have had to be rejected because the absence of the smaller and less conspicuous species showed the reports to be incomplete. *A census of breeding birds to be of any value must tell the whole truth; it is not sufficient that it shall tell the truth as far as it goes.*

Care must be exercised that the same individual be not counted more than once, as there is danger of doing in the case of species in which the two sexes are nearly or quite alike. This is one reason in favor of counting only singing birds, in so far as is compatible

with accuracy, though there will always be a few birds that fail to sing at the expected time.

A bird census should not be made until after the migration is over and the birds are settled on their nesting grounds. Occasionally belated migrants linger into the breeding season, but thorough familiarity with the local avifauna should make the elimination of these a simple matter. If, however, some unusual species found is near the edge of its known breeding range, its presence in the nesting season should be carefully investigated and the nest located if possible, to ascertain whether it is breeding there. Reports have sometimes been found useless because the counts were made so early in the season and certain species were so abundant that it seemed very probable that some of the individuals listed were not yet nesting but were migrants lingering in the southern part of their breeding ranges. Birds seldom nest in large numbers on the edge of their breeding range. On the other hand, if the count is made too late, the young of the species that nest early may be on the wing and may have left the area where they were raised.

A previous familiarity with the area surveyed is a help, and when it is necessary to make the count on land with which the enumerator is not well acquainted, it is a good plan to go over it several times before the actual census is taken, that the work may be done thoroughly and accurately.

In selecting an area on which to take a census, it is better not to choose a place where the birds are excessively abundant unless more than one count can be made. Such places are very interesting as showing how closely birds may breed, and data concerning them are useful in learning the total number of birds in the country, but they are not representative. If such a tract is chosen, the surrounding territory over which these birds feed should also be considered, preferably as a separate count. Such areas furnish excellent material for studies of local distribution and may yield interesting and valuable returns when an observer lives near enough and has the time necessary to make several counts of the area of concentration and of as much as possible of the surrounding territory. If these several counts are repeated year after year, the results will form valuable series of records.

Some persons seem to have the impression that a bird census is of no value unless it records a large number of birds per acre, and have considered it not worth while to make a count unless such a tract could be found. The actual truth concerning conditions is what is wanted, and knowledge of the distribution of bird life on any land contributes to this end. A count made on land that has few birds is just as important, therefore, as one made in a bird paradise, though probably not so interesting to the enumerator.

The final report should include an accurate description of the tract surveyed, indicating its nature, whether moist bottomland or dry upland; level, or broken and hilly; the number of acres in woods, orchard, and garden, in lawns about buildings, in each of the farm crops, and in pasture or meadow; and if there is waste land, whether it is marshy, upland, brushy, or the like. The value and usefulness of a report is increased if it contains information regarding the land surrounding the tract surveyed, whether it is wooded, cultivated, waste, or pasture; and if cultivated, whether in grain, hay, or garden

truck. Such supplementary information sometimes explains the presence of unusual numbers or species of birds on the tract surveyed.

MORE REPORTS NEEDED ON CERTAIN AREAS.

The most important phase of bird life concerns its relation to man and especially as it helps the farmer in destroying the enemies of his crops. It is more important therefore to ascertain how many birds inhabit the trees and shrubbery on the part of the farm actually devoted to crops and in the fields immediately contiguous to it than on land not devoted to agriculture; this should be borne in mind in all investigations along this line.

Another matter worthy of careful attention concerns the number of birds inhabiting certain areas which, while not devoted to agriculture, are important because of their nearness to centers of human occupation. Among such places are city parks, cemeteries, etc., where the presence of a large population of native birds is most desirable. That birds are quick to recognize the advantages of these sanctuaries, as they may be termed, where they find protection with food and shelter in plenty, is evidenced by reports that have been received of censuses made on areas that included such land.

In 1916 two tracts of 40 acres each in Golden Gate Park, San Francisco, averaged nearly 9 pairs of birds to the acre. At Omaha 12 acres of city park in 1916 had 33 pairs of native birds, representing 21 species, and 2 pairs of English sparrows; and in 1917 15 acres sheltered 70 pairs of 20 species, all native birds. Two years' counts made in the 44 acres of Woollen's Gardens, at Indianapolis, showed an average bird population of 320 pairs to 100 acres. In 1920, 80 acres of the campus of Wellesley College had 111 pairs of 34 species of native birds and 4 pairs of English sparrows. Five years' counts made on 95 acres in Highland Park, at Rochester, N. Y., show an average of 205 nesting pairs, with a maximum of 214 pairs in 1917.

RESULTS OF BIRD CENSUSES NORTH OF MARYLAND AND EAST OF THE PLAINS.

For the part of the country north of Maryland and the Ohio River and east of the Great Plains enough counts have been made (see Fig. 1) to make possible some deductions regarding the average bird population of the farm land. This territory was studied in considerable detail in 1915; but for the five years under discussion the material at hand is not sufficient to make practicable quite so detailed a study. The land surveyed has been classified, therefore, simply as fields, woodland, orchard, and plowed land. The last term, designating land in crops other than hay, is especially important in a study of the distribution of bird life, for very few birds nest on it; yet this is one of the types of land on which they are greatly needed.

In all reports and comparisons, and especially in the tables of averages, the character of the land surveyed, judged on the basis of averages or percentages, is of primary importance, since this is the principal factor determining the number and kinds of birds that will be found nesting there. Two adjacent farms of the same size may support the same number of pairs of breeding birds and yet have few species in common, because one farm is upland and

the other bottomland; one a dairy farm, the other devoted principally to grain raising; or because the trees of one are largely hardwoods and of the other, evergreens. Or one farm may have a very large bird population, while an adjoining farm of the same size has few birds, the first having a large orchard or much shrubbery and many trees, while the second has few trees or is intensively cultivated.

The majority of the censuses thus far received have resulted from counts made on that part of the farm surrounding the house and other buildings, including the garden, the orchard, and the lawn with its shrubbery and shade trees. Here are many attractive nesting sites and an abundant food supply, and here also will be made most of the efforts toward attracting birds, by the placing of food, nest boxes, and bird baths. This is the part of the farm, therefore, where birds are most abundant.

According to the decennial census of 1910, the average farm in the section north of Maryland and east of the Plains contains 108 acres,

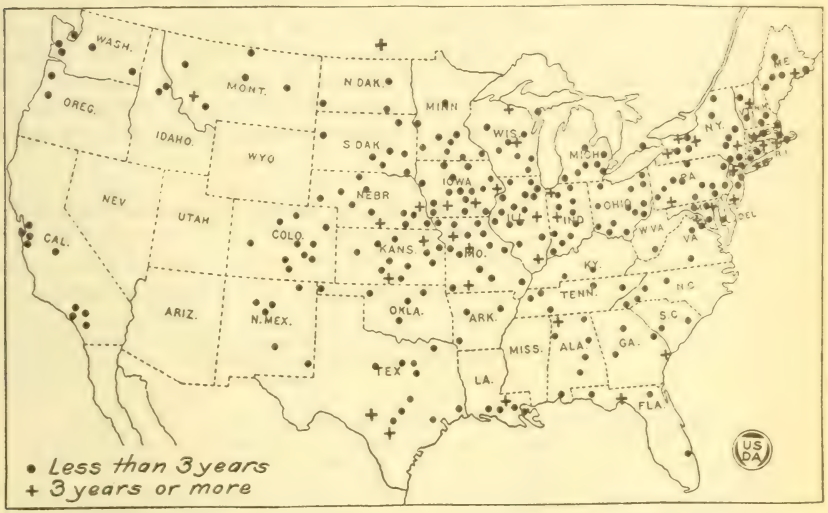

FIG. 1.—Localities from which reports on bird censuses were received for the five years 1916 to 1920.

of which 1.2 per cent, or about 1⅓ acres, is orchard. The counts from this section covered an average of about 76 acres each, including 4½ acres of orchard, which represented nearly 6 per cent of the total land surveyed, and on the above basis would be over 4 per cent of the farm. To the birds the orchard is the most attractive part of the farm. Since the farms on which these counts were made had about four times the normal acreage in orchard, they must be regarded as unusually rich in bird life.

The records deal principally with the 76 acres of the farm about the buildings, and for the five years show an average population of 100 pairs of breeding birds. There remain unsurveyed about 32 acres of the more thoroughly cultivated parts of the farm that contain little woodland and probably few birds. Judging from counts made on farms that were largely under cultivation, the average bird population of these 32 acres would probably be little, if any, over 20 pairs. For this five-year period, therefore, the farm of 108 acres

had an average bird population of 120 pairs, while in 1914 and 1915 the average was estimated to be 119 pairs. Fluctuations in the number of birds per acre that occurred from year to year may be noted in Table 1.

Table 1 summarizes the results of censuses taken on farm land in this section for the five years 1916 to 1920. For the sake of the rather interesting comparison possible and because conditions in the eastern part were somewhat different from those in the western, this section was divided into two parts—the Northeastern States, including New England, New York, New Jersey, and Pennsylvania; and the North Central States, those north of the Ohio River between Pennsylvania and the Plains; and the results have been so tabulated. Only four years' records are included for the first-named division because of the limited number of reports covering farm land received in 1919.

According to the 1910 census, the farms in the Northeastern States have, on an average, slightly over 58 per cent of the land improved, and in the North Central States, nearly 76 per cent. Allowing for a few acres of hay on each farm, the areas surveyed in both sections have approximately 50 per cent of the land improved, making these tracts above the normal farm in the proportion of the land that is favorable to bird life; especially when the large acreage of orchard represented is considered.

TABLE 1.—*Results of bird censuses of farm land in the Northeastern and North Central States, 1916 to 1920.*

	Northeastern States.					North Central States.					
	1916	1917	1918	1920	Average, 4 years.	1916	1917	1918	1919	1920	Average, 5 years.
Average size of area covered by each count.....acres..	64	79	89	61	73	64	70	57	116	90	79
In fields.....do....	48	57	70	46	55	48	54	46	97	70	63
In orchard.....do....	5	8	8	4	6	2	2	1	12	1	4
In woodland.....do....	11	14	11	11	12	14	14	10	7	19	13
In plowed land (field crops other than hay).....acres..	13	37	49	12	28	20	29	22	68	28	33
Proportion of the land covered in—											
Fields.....per cent..	75	72	79	75	75	75	77	80	84	78	79
Orchard.....do....	8	10	9	7	9	3	3	2	10	1	4
Woodland.....do....	17	18	12	18	16	22	20	18	6	21	17
Field crops other than hay .....per cent..	20	47	55	20	36	31	41	38	68	31	42
Average bird population on each area counted.....pairs..	102	98	85	91	94	89	90	86	156	112	107
Average bird population per 100 acres on land counted.....pairs..	159	124	95	149	132	139	129	150	135	124	135

In the northeastern section this small amount of cultivated land may be partly balanced by the relatively small proportion of woodland. The census of 1910 indicates that the woodland comprises 27.2 per cent of the farm, but only slightly over 16 per cent of the land on which counts were made was in woods. In the North Central States, however, the woodland of the tracts counted was about 3 per cent in excess of the normal as given by the census, which, in conjunction with the small proportion in crops and the large amount of orchard—the latter over three times the normal—makes the land sur-

veyed very favorable to bird life. The woodland in farms is usually in comparatively small lots, and the figures indicate that the average bird population of such plots is nearly four times as dense per acre as that of the land devoted to crops.

Under the designation "fields" there are included, besides the land in crops, the area in lawns about the houses, driveways, pasture, and meadowland. It is obvious that the remainder of the farm, the part not included in the counts, must be largely under cultivation, and will therefore afford nesting places for very few birds. Exact counts are needed from this part of the farm, in addition to those made on the land surrounding the buildings, to determine just how many birds do nest there. If these are made as separate counts, their interest and value will be increased.

The average farm in the Northeastern States contains between 97 and 98 acres, and the censuses here deal with 73 acres, leaving about 25 acres unsurveyed. Most of these 25 acres are under cultivation, and returns indicate that under such conditions the bird population is about 54 pairs per 100 acres, or 13 pairs on this section of the farm. Since 94 pairs were found to inhabit the 73 acres surrounding the buildings, the average farm of 97 acres would have 107 pairs of nesting birds.

In the North Central States the average farm contains 123 acres, 79 acres of which are covered by the counts, leaving 44 acres not surveyed, which must be largely under cultivation. In this section we find that such land supports about 71 pairs to the 100 acres; therefore these 44 acres would have 31 pairs of birds. The 79 acres of the counts were found to have 107 nesting pairs, making a total of 138 pairs of birds on the 123 acres of the average farm.

The average bird population to the 100 acres on farms in the Northeastern States is 111 pairs, and in the North Central States 112 pairs.

RESULTS OF CENSUSES FROM SOUTHEASTERN STATES.

Very few reports were received from the South Atlantic and Gulf States, and, since only about half of them deal with farm land, the acreage covered by counts is much too small to allow any deductions regarding the average bird population in this section as a whole. Moreover, less than half the States of the section are represented by these counts. Census returns indicate that the woods and improved land of the farms in this section each represent between 46 per cent and 47 per cent of the total acreage farmed, and that less than 1 per cent is in orchard.

FLORIDA.

Reports received from Florida in 1916 concerned land which had about 39 per cent in woods and 17⅓ per cent in crops, and showed less than one pair of breeding birds to the acre.

ALABAMA.

Land surveyed in Alabama in four different years averaged slightly over 52 per cent woods, 1 per cent orchard, and 34 per cent in crops. For the four years this land supported an average bird population

of 126 pairs to the hundred acres. One tract of 40 acres, in 1918, suffered the heaviest loss in the breeding population noted on a single area. Several species found in 1917 were entirely absent the following year, among them being the mockingbird and the brown thrasher, each of which had been represented by two pairs, besides several species of insectivorous birds. In 1917 there were three species and four pairs of woodpeckers, and in 1918 not a woodpecker was present.

TENNESSEE.

An average bird population of 107 pairs to the hundred acres was found in Tennessee in 1917 on land that contained no woodland or orchard and had 40 per cent in crops.

LOUISIANA.

Returns from Louisiana deal with land that was exceptionally favorable to bird life, in the years 1916 to 1918, inclusive. A little over 35 per cent of this area was in woods and more than 3 per cent in orchard, while only 20 per cent was cultivated. The average bird population for the three years was slightly over two pairs to the acre.

RESULTS OF CENSUSES FROM WESTERN STATES.

Reference to the map (Fig. 1, p. 7) will show that reports on bird censuses from the western part of the country are very few indeed. In this vast area stretching from the Plains to the Pacific physical conditions are greatly diversified, and climatic conditions range from humid on the eastern border through various degrees of aridity to the humid region of the Pacific coast. Nothing more definite can be said of the bird life of this area than that it is very variable. In all parts of the country birds are inclined to concentrate in places where water is available and trees and bushes offer shelter, and, judging from present returns, this is especially true over the western part of the country, particularly in the Plains region, where only a few species nest on the open prairies.

Beyond the Plains, in the Rocky Mountain region, is presented the additional problem of altitude, and here there is also much heavy forest, where birds are far from abundant, as the bird counts at hand show. The valleys, when not cultivated, are frequently arid and furnish nesting sites for few species of birds.

The Great Basin, between the Rockies and the Sierras, offers many interesting problems. Reclamation projects are bringing under cultivation many thousands of acres of land formerly desert, and changes in the bird life, both in species and in numbers, will result; it is therefore very desirable that as many counts as possible be obtained immediately from this region in order that material may be at hand on which to base comparisons in the future.

For the Plains region from North Dakota to Oklahoma data are too few and scattered to allow any generalizations, except that birds are seemingly less abundant than in the more humid regions farther east, and also that they are very unevenly distributed. There are few extensive tracts of woodland, the trees being largely confined to planted groves and to strips along the river bottoms, and here, where water and shelter are to be had, birds are sometimes enormously abundant.

KANSAS.

Two series of records from Kansas are so suggestive as to warrant quoting at some length. One is from Onaga, near the northeastern corner of the State, well within the humid belt, and the other is from the south central part, at Harper, on the Plains.

At Onaga counts were made for five years on a 40-acre tract, half of which was planted to corn; the 4-acre lot containing the buildings is bordered by hedge, and 6 acres of grove extend along two sides; and there are 5 acres each of orchard and pasture. For the five years this tract held an average bird population of 50 pairs of 24 species, or an average of 125 pairs of birds per 100 acres. In 1916 only the 10 acres surrounding the house and including part of the grove and orchard were surveyed; but this small section held 37 pairs of birds representing 22 species, leaving only some 15 pairs of birds to nest on the remaining 30 acres of this entire tract, only a few more than on the adjoining open prairie. This 40-acre tract of native prairie is somewhat hilly, with a small stream fringed with trees and brush, boxelder, willow, white elm, and dogwood. The average bird population here for four years was 13 pairs of 10 species, a rate of 33 pairs of birds per 100 acres. (See Tables 2 and 3.)

TABLE 2.—*Birds nesting on 40 acres about house at Onaga, Kans.*

(Figures for 1916 refer to 10 acres only).

Species.	1914	1915	1917	1918	1920	1916
†Green heron					1	
*Bobwhite	1	1	1	2	1	1
*Mourning dove	3	8	3	5	3	3
†Screech owl		1				
*Yellow-billed cuckoo	3	2	1	1	1	2
†Hairy woodpecker			1			
†Downy woodpecker			2			
*Red-headed woodpecker	2	2	2	1	2	1
*Flicker	2	1	1	1	1	1
Nighthawk	1			1		
*Kingbird	3	1	1	1	1	1
*Crested flycatcher	1	1	1	1	1	1
Phoebe	1	1	1	1		1
*Blue jay	1	2	1	1	2	2
Cowbird	1				1	
†Red-winged blackbird					1	
*Orchard oriole	3	3	1	2	2	1
*Baltimore oriole	2	1	2	1	1	1
Bronzed grackle	8				3	1
†Goldfinch			1			
†Pine siskin					1	
†Grasshopper sparrow	1					
Lark sparrow		1			1	
Field sparrow				1	2	
Cardinal			2	3	1	1
†Blue grosbeak			1			
Dickcissel	3	2		1	1	
*Barn swallow	6	6	5	7	8	8
Warbling vireo	1	1		1		1
*Bell vireo	1	3	3	2	6	1
Yellow warbler	1	1	1	2		1
Maryland yellowthroat	1		1			
†Chat						1
*Catbird	4	5	4	4	5	3
*Brown thrasher	2	3	2	4	5	2
House wren	2	2	1		3	2
Long-tailed chickadee	1			1		
*Robin	1	1	1	2	1	1
English sparrow				2	2	
Total number of species	26	22	24	24	26	22
Total number of nesting pairs	56	49	40	48	57	37

*Present every year. †Present only one year.

TABLE 3.—*Birds nesting on 40 acres of prairie at Onaga, Kans.*

Species.	1916	1917	1918	1920	Species.	1916	1917	1918	1920
Bobwhite	1	1	1	....	Dickcissel	2	1	....	1
†Mourning dove	....	....	1	....	Bell vireo	1	1	1	....
†Downy woodpecker	....	....	1	....	Catbird	1	....	3	....
†Red-headed woodpecker	....	1	....	....	Brown thrasher	....	1	1	1
†Blue jay	1	....	....	....	†House wren	....	....	1	....
Cowbird	....	1	2	....	†Long-tailed chickadee	1	....	....	....
†Orchard oriole	....	....	1	....	Bluebird	1	....	1	1
†Goldfinch	....	....	1	....					
*Grasshopper sparrow	3	4	1	1	Total number of species	10	9	15	6
*Lark sparrow	1	1	1	2	Total number of nesting pairs	15	12	18	7
*Field sparrow	3	1	1	1					
†Cardinal	....	....	1	....					

*Present every year. †Present only one year.

Two tracts of 80 acres each near Harper show a similar contrast. The first, on which reports were made in 4 different years, comprised 35 acres of alfalfa and sweet clover, 12 acres of grain, 15 acres of pasture through which a stream runs, forming a small swamp of perhaps 2 acres, and 15 acres in the orchard, grove, and garden around the buildings, besides which there was a 1-acre grove of young catalpa trees. On this tract the average nesting population was 122 pairs of 34 species, or 153 pairs per 100 acres.

The adjoining 80 acres consisted of 45 acres of prairie pasture, 2 to 4 acres of alfalfa, and the rest planted to wheat or cane. There was in this case also a stream and tiny swamp that attracted a few red-winged blackbirds. Two years' reports showed this tract to be the home of very few birds. The first year 16 pairs of 8 species were found nesting; the second, 26 pairs of 9 species; an average of 26 pairs per 100 acres, a marked contrast to the first tract.

OKLAHOMA.

Near Norman, Okla., a count made in 1920 showed 31 pairs of birds nesting on 40 acres. Of this land, 10 acres were prairie pasture and the rest planted to corn, cotton, and oats. Two dickcissels and one meadowlark nested in the pasture, one bobwhite in the oats, and the other 27 pairs of birds in trees and bushes along the stream which flows through the tract.

TEXAS.

Near Taylor, Tex., in 1916 a tract of 104 acres, of which 45 acres were in cotton and 35 acres in sheep pasture, had only 29 pairs of nesting birds. From the following list it will be seen that most of these birds nested in the 8 acres of trees and shrubbery on the borders of a creek crossing one side of the tract. The pairs of birds found were as follows:

Killdeer, 1; bobwhite, 1; mourning dove, 1; red-bellied woodpecker, 1; scissor-tailed flycatcher, 2; Acadian flycatcher, 1; cowbird, 2; orchard oriole, 1; bronzed grackle, 2; lark sparrow, 3; cardinal, 4; painted bunting, 1; mockingbird, 5; Carolina wren, 1; English sparrow, 3.

Near Paris, Tex., in 1916, 80 acres of shrub-covered pasture showed an average of 129 pairs of birds per hundred acres; and several tracts in the vicinity of Fort Worth the same year had an average of 120 pairs per 100 acres. No data are available concerning the bird population of the plains region of Texas.

MONTANA.

From Montana may be cited two reports that show an interesting diversity of bird population within the borders of a single State. Counts were made on 40 acres of park land belonging to the city of Missoula in the years 1915, 1917, and 1920. In describing this tract in 1915, Joseph Kittredge, jr., says:

> The park is an isolated and specialized association for the upper bench, and the hills around for several miles are open and treeless Transition Zone prairie country. Still farther back is the coniferous forest; hence in this area there is a concentration of species which are typical of the creek bottoms throughout the Transition Zone of the region.

On this area in 1915 there were found nesting 59 pairs representing 20 species; in 1917, 58 pairs of 19 species; and in 1920, 100 pairs of 25 species.

In contrast to this, in 1916, near Fergus, Mont., a count on 80 acres of sagebrush prairie found only 8 pairs of birds representing 5 species, 1 pair to 10 acres, almost exactly agreeing with the count on 40 acres of native prairie near Missoula in 1915.[3] A mile and a half away, in the trees and bushes along the creek, birds nested abundantly, but no count was made in that section.

NEW MEXICO.

Two counts made by J. K. Jensen in 1920, in the vicinity of Santa Fe, N. Mex., are of interest, because they indicate somewhat the difference in bird life between the cultivated land and heavy forest of the region; but being at different altitudes they are not entirely comparable. The first was made on 106 acres of the land of the United States Indian School, near Santa Fe, at an altitude of 7,000 feet. Of this land, 12 acres, or about 11 per cent, was uncultivated, covered with sagebrush and cactus, with a few junipers. The remaining area is divided as follows: Buildings and campus, 27 acres; orchard, 4 acres; garden, 4 acres; wheat, 16 acres; corn, 25 acres; and alfalfa, 18 acres. This indicates that a large part of the area surveyed was under irrigation, and water always helps to attract birds. On this 106 acres were found breeding 121 pairs of native birds, representing 22 species, besides 100 pairs of English sparrows, a total of 221 pairs of birds. This is an average of 114 pairs of native birds and a total of 208 pairs of birds per 100 acres. The following list shows the species and the number of pairs of each:

> Killdeer, 1; scaled partridge, 1; desert sparrow hawk, 1; flammulated owl, 1; Cassin kingbird, 2; Say phoebe, 3; western wood pewee, 4; desert horned lark, 4; western meadowlark, 4; Bullock oriole, 1; house finch, 50; Arkansas goldfinch, 13; pine siskin, 1; western vesper sparrow, 4; western chipping sparrow, 8; Brewer sparrow, 8; black-headed grosbeak, 1; western blue grosbeak, 1; barn swallow, 1; Sonora yellow warbler, 2; western robin, 6; mountain bluebird, 4; English sparrow, 100.

The other report deals with 90 acres of the Santa Fe National Forest, situated at an altitude of 8,000 feet. This land extends for about two-fifths of a mile along the Santa Fe River, and 1,000 feet from either side of the stream. The canyon bottom is covered with brush and aspens; and the slopes of the mountains, which rise quite abruptly for about 3,000 feet, are heavily forested. In this area were found 48 pairs of 20 species, all native birds. This is at a

[3] U. S. Dept. Agr. Bul 396, p. 9.

rate of about 53 pairs of breeding birds per 100 acres. Mr. Jensen's description of this territory is interesting:

This being my favorite hunting ground, practically every nest mentioned was located. The east slope of the canyon is covered with pine and spruce down to the level bottomland. All thrushes were found on this side. The west slope is covered with oak in which the evening grosbeaks and juncos were found. This is virgin country with numerous signs of bear, mountain lion, and wildcat.

The following are the birds found breeding:

Red-naped sapsucker, 2; red-shafted flicker, 2; western wood pewee, 1; western flycatcher, 3; Traill flycatcher, 1; long-crested jay, 1; western evening grosbeak, 2; red-backed junco, 2; sage sparrow, 6; western tanager, 1; violet-green swallow, 8; least vireo, 3; Audubon warbler, 3; water ouzel, 1; Baird wren, 2; pygmy nuthatch, 2; Townsend solitaire, 2; Audubon hermit thrush, 2; western robin, 2; chestnut-backed bluebird, 2.

WASHINGTON STATE.

Near Pullman, Wash., four counts were made in 1920 by students of the State College of Washington, under the direction of Prof. W. T. Shaw. These counts covered a total of 162 acres of land divided as follows: Woods, 5 acres, or 3 per cent; orchard, 13 acres, or 8 per cent; and fields, 144 acres, or 89 per cent; with 79 acres, or 49 per cent of the whole area, under cultivation. With the exception of 4 acres of garden, the land cultivated was in grain, mostly wheat. On these 4 tracts, apparently not continuous, 184 pairs of birds, including 5 pairs of English sparrows, were found breeding. This is an average of 114 nesting pairs per 100 acres.

The only report from the northwest coast region is from Gig Harbor, on the upper reaches of Puget Sound. Here, in 1916, an 80-acre tract was found to shelter 144 pairs of nesting birds, representing 48 species; and the next year the same land had 185 pairs of 43 species. Conditions on this tract were exceptionally favorable for birds, so that these figures can hardly be taken as representative of the region as a whole.

CALIFORNIA.

Probably no State has a greater diversity in its bird life than California, with conditions varying from the humid coast to the deserts of the interior and to the high mountains. No generalizations concerning the bird population can be made until counts have been made on a very large scale. No reports have yet been received from the northern part of the State nor from the sections less favorable to bird life. All counts received have been made on cultivated land, except those from the region of San Francisco Bay. These show a good deal of diversity, as will be seen from the examples quoted.

A record density of bird life is found in Golden Gate Park, San Francisco, where conditions are unusually favorable. Across the bay on 20 acres of Strawberry Creek Canyon, a part of the campus of the University of California, there were found breeding, in 1916, 93 pairs of birds, representing 30 species. None of this land was cultivated and much of it was wooded. The birds found were as follows:

California quail, 3; screech owl, 1; red-shafted flicker, 2; Anna hummingbird, 4; Allen hummingbird, 2; olive-sided flycatcher, 1; western wood pewee, 1; western flycatcher, 4; coast jay, 1; California jay, 4; California purple finch, 1; willow goldfinch, 1; green-backed goldfinch, 2; Santa Cruz song sparrow, 10; San Francisco towhee, 9; California brown towhee, 5; black-headed grosbeak, 1; lazuli bunting, 2;

cliff swallow, 3; warbling vireo, 3; Hutton vireo, 1; lutescent warbler, 4; Macgillivray warbler, 2; pileolated warbler, 2; California thrasher, 1; Vigors wren, 4; plain titmouse, 1; intermediate wren-tit, 5; coast bush-tit, 5; russet-backed thrush, 8.

Near Fresno, in 1920, a 40-acre tract showed only 18 pairs of birds, including 3 pairs of English sparrows. Of this land 25 acres were in vineyard, 3 in orchard, 6 in alfalfa, and 6 in pasture. The 12 species found were distributed as follows:

Killdeer, 1; valley quail, 1; barn owl, 1; Pacific nighthawk, 1; western meadowlark, 1; Bullock oriole, 2; house finch, 3; willow goldfinch, 1; western blue grosbeak, 1; California yellow warbler, 1; western mockingbird, 2; English sparrow, 3.

At Banning a census was made on 40 acres, about half of which was in orchard and the rest mostly in grain, with three small gullies filled with herbage. This tract showed just 1 pair of birds to the acre, 23 of the nests being actually located. There were no English sparrows, and the 15 species of native birds were:

Valley quail, 2; mourning dove, 6; Texas nighthawk, 2; black-chinned hummingbird, 1; California horned lark, 2; Bullock oriole, 1; hooded oriole, 1; house finch, 2; willow goldfinch, 1; green-backed goldfinch, 7; lark sparrow, 5; western chipping sparrow, 1; Anthony towhee, 6; California shrike, 2; yellow warbler, 1.

A count on 68 acres near Buena Park, Orange County, showed the bird population in 1920 to be only a little over one pair to 2 acres. Of this area, 33 acres were in barley, 12 in beans, 5 in garden, and the rest in pasture or uncultivated. The 16 species and 39 pairs were as follows:

Killdeer, 1; valley quail, 7; mourning dove, 3; barn owl, 1; burrowing owl, 1; black-chinned hummingbird, 1; Anna hummingbird, 1; western kingbird, 1; California horned lark, 2; western meadowlark, 6; Bullock oriole, 2; Brewer blackbird, 2; house finch, 4; green-backed goldfinch, 3; Lawrence goldfinch, 1; California shrike, 3.

Escondido is the point farthest south in California from which counts were received, and one was made here in 1918 on a tract of 80 acres. About 25 acres of this area were devoted to hay, and the rest was divided between fruit trees, brush, and other trees, mostly eucalyptus. Here were found 129 pairs of nesting birds, but only 18 species:

Valley quail, 5; western mourning dove, 27; black-chinned hummingbird, 3; Anna hummingbird, 1; Arkansas kingbird, 2; black phoebe, 1; California horned lark, 12; California blue jay, 1; western meadowlark, 10; Arizona hooded oriole, 2; house finch, 35; willow goldfinch, 5; Arkansas goldfinch, 10; western lark sparrow, 5; Anthony towhee, 7; phainopepla, 1; California shrike, 1; western mockingbird, 1.

SOME NOTABLE BIRD-CENSUS RESULTS.

Geneva, N. Y.—An extensive series of counts from the vicinity of Geneva, N. Y., for the three years 1916 to 1918, made by Otto McCreary, seems worthy of rather detailed presentation. (See Table 4.) Comparison of the results obtained here with those of New York State as a whole for the same years indicates to some extent how sample areas, if representing the average conditions for their respective localities, make generalizations possible, but shows also that many localities are needed to determine the final averages. When considering the results, it is to be remembered that the figures from the State as a whole include those from Geneva and that all the present data deal with land which is or might be farmed, no reports having been received from the mountain regions of the Adirondacks and Catskills.

A greater decrease in the number of birds per acre is noted in 1917 than in 1918; reference to the table shows, however, that the decrease in 1917 is accounted for by the difference in the character of the land surveyed, while that of 1918 is a part of a general decrease throughout the eastern United States. One plot of 92 acres, reported upon all three years, shows in 1918 fewer individuals of certain species that figure in the decreases elsewhere (see p. 28).

TABLE 4.—*Comparison of results of bird censuses taken at Geneva, N. Y., with all those from the State of New York.*

	Geneva, N. Y.						
	1916		1917		1918		Average.
	Acres.	*Per cent.*	*Acres.*	*Per cent.*	*Acres.*	*Per cent.*	*Per cent.*
Areas covered by censuses	155		1,307		1,712		
In fields	75	48	943	72	1,373	80	67
In orchards	45	29	145	11	150	9	16
In woods	35	23	219	17	189	11	17
Plowed land	68	44	895	68	1,193	70	61
Nesting birds counted:	*Pairs.*		*Pairs.*		*Pairs.*		
Native species	205		1,037		1,143		
All species	221		1,115		1,270		
Bird population per 100 acres and percentage of total:							
Native birds	132		79		66		
All species	142		85		75		
Robin	27	19	7	8	8	11	13
Catbird	4	3	1—	1—	1—	1—	2—
Song sparrow	15	11	15	18	17	23	17
Chipping sparrow	19	13	4	5	3	4	7
English sparrow	10	7	5	6	7	9	7

	New York State.						
	1916		1917		1918		Average.
	Acres.	*Per cent.*	*Acres.*	*Per cent.*	*Acres.*	*Per cent.*	*Per cent.*
Areas covered by censuses	851		1,793		1,860		
In fields	560	66	1,277	71	1,507	84	74
In orchard	91	11	186	10	150	8	10
In woods	200	24	330	18	203	11	18
Plowed land	208	24	1,002	56	1,198	64	48
Nesting birds counted:	*Pairs.*		*Pairs.*		*Pairs.*		
Native species	1,344		1,914		1,444		
All species	1,435		2,063		1,585		
Bird population per 100 acres and percentage of total:							
Native birds	158		107		77		
All species	167		115		85		
Robin	23	14	12	10	10	12	12
Catbird	7	4	3	3	2	2	3
Song sparrow	16	10	16	14	17	20	15
Chipping sparrow	11	7	6	5	4	5	6
English sparrow	8	5	7	6	7	8	6

Referring again to the 1910 census, we find that in the State of New York 19¼ per cent of the land in farms was woodland and 64½ per cent was improved, of which slightly under 3 per cent of the total was orchard. The 16 per cent of orchard in the land surveyed about Geneva is thus considerably in excess of the normal for the State; but this is partially balanced by the low amount of woodland, here more than 2 per cent below the normal. Plots of woodland containing from 12 to 95 acres were counted but were not so rich in bird life as woodlots usually are, the average for the three years being only 87 pairs to the 100 acres, less than half the average found

for such land. This, together with the large amount in crops (plowed land), nearly 60 per cent, accounts for the fact that here, in spite of the excess of orchard, the number of birds per acre is less than for the State as a whole or for the Northeastern States. For the entire State the total amount of improved land covered by bird censuses is not far below the normal, though the proportion of orchard is very large, and the woodland also is a little below the percentage given by the official census of 1910. The average bird population for the State agrees very closely with that of the northeastern section for the same years, that for New York State being 122 pairs and for the entire section 126 per 100 acres; at Geneva the average for the three years is just one pair to the acre.

Viresco, Va.—The longest series of bird counts on file concerns a tract of about 55 acres at Viresco, Va., not far from Washington, and extends over 10 years. This tract has the added interest that the experience gained in making the earlier counts here formed the basis for the 1914 circular of instructions for taking a bird census.

The land includes 21 acres of woods, 18 of pasture, 5 of land plowed for grain and garden, 3 of brushy hillside, and the remaining 8 acres in trees and brush along a stream that meanders through the place. Most of the cleared land had been cultivated up to a short time before the area first came under observation in 1907, and it was then growing up to brush. At that time the underbrush in the woods had recently been thoroughly cleared, but it has since grown back, and the small trees and brush along the stream have grown considerably. One plot of 3 acres, formerly cultivated, has been allowed to grow wild, and in midsummer about half of it is an almost impenetrable tangle of brush overgrown with catbriar, honeysuckle, and wild grape. Since about 1916 a large part of the chestnut trees have died out of the woods, but the dead trees have been cut each winter, giving a chance for the other species, principally oak and tulip, so that there has been little noticeable thinning of the woods. From 1916 to 1918 about 4 acres of pasture were set to orchard, but as yet the trees have not made sufficient growth to alter the character of the land.

Throughout this period birds have been strictly protected, but the only efforts toward attracting them have been the erection of a small martin house (scorned, however, by the martins, though several times occupied by bluebirds or house wrens), and recently two or three wren houses. No special feeding has been done at any time. The counts on this tract show a steady increase in the number of birds breeding until 1918, when there was a decrease of over 20 per cent; the average of 1916–17 was fully recovered, however, by 1920.

An excellent example is here furnished of what protection alone can do toward increasing the number of birds nesting on a given area. The growth of the bird population has been greater than that warranted by the increased supply of food and shelter; it seems probable that it has resulted in part, at least, from recognition by the birds of the security of this tract as a nesting place. Unfortunately, it has been impracticable to make counts on the adjacent territory and thereby to ascertain whether any decrease has occurred in its bird life as a result of the increase on the tract surveyed.

During the 10 years 51 different species of birds have nested on this tract, the number present in any one year varying from 27 to 39, and the number of nesting pairs from 48 in 1911 to 105 in 1917, the maximum to date. (See Table 5).

TABLE 5.—*Birds nesting on 55 acres at Viresco, Va.*

Species.	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
Bobwhite	.....	.....	.....	.....	1	.....	.....	1	1	.....
Mourning dove	.....	.....	.....	.....	1	.....	1	.....	1	.....
†Screech owl	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Yellow-billed cuckoo	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Hairy woodpecker	.....	.....	.....	1	.....	.....	1	.....	.....	.....
Downy woodpecker	1	1	1	.....	1	1	1	1	1	1
Flicker	.....	.....	.....	.....	.....	1	1	1	1	1
Whippoorwill	1	1	.....	1	1	2	2	2	1	1
Chimney swift	.....	.....	.....	.....	.....	.....	.....	1	1	1
Hummingbird	.....	.....	1	.....	.....	.....	.....	1	1	.....
Kingbird	.....	1	1	.....	.....	1	1	1	1	1
Crested flycatcher	1	.....	1	1	1	1	2	1	1	3
*Phoebe	2	1	1	1	3	2	4	1	1	2
*Wood pewee	2	1	2	3	2	5	6	1	2	3
Acadian flycatcher	.....	1	1	1	2	3	7	3	5	5
Blue jay	.....	.....	.....	.....	1	1	1	2	1	1
Crow	.....	1	.....	1	1	2	1	1	2	1
†Meadowlark	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
†Orchard oriole	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
†Purple grackle	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Grasshopper sparrow	1	1	1	.....	.....	1	1	.....	1	1
Chipping sparrow	.....	1	1	1	1	2	3	2	3	3
*Field sparrow	3	3	4	4	7	4	4	4	4	6
*Song sparrow	6	6	6	5	3	5	4	4	5	7
*Chewink	2	1	2	2	1	2	2	1	2	1
*Cardinal	1	2	2	2	2	3	4	4	6	4
*Indigo bunting	3	3	1	3	3	6	6	4	5	7
*Scarlet tanager	1	2	2	2	1	1	4	1	1	1
*Rough-winged swallow	1	1	1	1	1	1	1	1	1	1
*Red-eyed vireo	2	3	4	9	7	8	4	6	7	8
Yellow-throated vireo	1	2	2	5	2	2	.....	1	.....	1
*White-eyed vireo	1	1	3	3	2	2	1	1	1	1
Black and white warbler	1	1	2	2	3	2	.....	1	1	2
†Worm-eating warbler	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
†Parula warbler	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Yellow warbler	.....	.....	.....	.....	.....	.....	1	1	.....	1
*Ovenbird	3	4	4	6	6	9	8	5	5	6
†Louisiana water-thrush	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
*Maryland yellowthroat	4	4	5	3	5	4	5	6	3	2
*Chat	2	2	1	3	2	2	1	2	1	4
Hooded warbler	1	.....	1	1	2	2	1	1	.....	2
*Redstart	1	2	2	2	4	4	3	3	5	5
*Catbird	3	2	4	5	7	5	7	7	6	4
Brown thrasher	.....	.....	1	.....	.....	1	2	1	.....	.....
Carolina wren	1	1	.....	.....	1	.....	.....	.....	.....	.....
House wren	1	.....	2	1	1	1	1	.....	.....	2
*Tufted titmouse	1	1	1	2	2	1	2	1	1	3
Carolina chickadee	.....	1	1	.....	1	.....	.....	.....	.....	1
Wood thrush	.....	1	1	2	2	3	4	3	4	2
Robin	1	.....	.....	.....	.....	2	4	2	1	2
Bluebird	.....	.....	1	.....	1	2	2	1	1	1
Total number of species	27	30	32	29	34	36	38	37	36	39
Total number of nesting pairs	48	53	63	74	81	95	105	81	85	100

* Present every year. † Present only one year.

Rantoul, Ill.—On a 400-acre tract near Rantoul, Ill., counts were made in four years, from 1916 to 1920. There are two small orchards, together amounting to about 5 acres, with a garden near the house and hedges and large trees about the buildings. Of the remainder of the tract, about 300 acres were planted each year in corn and oats and 50 acres were in permanent pasture and meadow. The birds found breeding here have varied from 231 pairs of 35 species, to 340 pairs of 48 species, averaging 293 pairs and 42 species on the 400 acres, or 73 pairs per 100 acres.

In 1918 the count was made on the 160 acres of this tract that contained the buildings with surrounding trees, all the garden, and one orchard. Ninety-eight acres were in corn and the remainder in pasture and meadow. This count found 152 breeding pairs of 26 species, including 12 pairs of English sparrows, an average of 95 pairs of birds to 100 acres. This is a rather small bird population, but comparing these figures with those in other years, it is found that on the remaining 240 acres there would be only about 140 pairs of birds nesting, an average of 58 pairs per 100 acres. As regards the number of breeding birds, the conditions on this farm would probably be typical of many thousands of acres in the grain-raising States of the Middle West.

Kerrville, Tex.—An interesting series of records from south-central Texas, near Kerrville, covers the six years 1914 to 1919. This land is not on the Plains but in the broken country which marks the transition from the high Staked Plains to the low coastal plain. The country as a whole is characterized by rough limestone hills broken by numerous small rocky canyons densely covered with scrub, and has some springs. The counts made here were on 80 acres, of which about 35 were under cultivation, including ½ acre of orchard and 1 acre of garden. The character of the land is best described in Howard Lacey's own words:

> My house is situated on the point of a hill at the junction of two narrow canyons, one coming in from the west and the other from the north; below the junction they run south until they join Turtle Creek (a tributary of the Guadalupe River) after crossing the main road going up and down that creek.
>
> The west canyon, which averages about 100 yards wide, and most of the valley below the house (from 200 to 300 yards wide) are in cultivation wherever they can be cultivated and are generally in oats, corn, and sorghum; there is also a small garden and orchard. A little creek winds down the valley now on one side now on the other, and is subject to overflow and at times is nearly dry but never entirely so. A small irrigation ditch which is taken out of the west canyon is brought round by the house and then joins the creek again.
>
> Both creek and ditch are fringed with brush and about one-third of the valley is given up to thicket and small groves of trees.
>
> The valley is shut in by steep hillsides about 100 feet high, like the sides of a box, so steep that one has to use one's hands to climb them in most places, densely covered with small trees.

An exact enumeration of the black-chinned hummingbirds and cowbirds was found impossible, the latter being here very numerous and destructive to the smaller passerine birds, few nests of which are found without cowbirds' eggs. This ranch had as yet no English sparrows. During the six years 45 different species of birds were found nesting on this tract, 28 of which were present every year. Exclusive of the hummingbirds and cowbirds, the bird population of this tract averaged 147 pairs per 100 acres. (See Table 6.)

TABLE 6.—*Birds nesting on 80 acres near Kerrville, Tex.*

Species.	1914	1915	1916	1917	1918	1919
Green heron	.....	1	1	.....	.....	.....
Killdeer	.....	1	1	.....	.....	.....
Texas bobwhite	1	1	1	3	.....	.....
*Western mourning dove	3	3	6	5	5	6
†Black vulture	.....	.....	1	.....	.....	.....
†Cooper hawk	.....	.....	.....	1	.....	.....
Aiken screech owl	.....	.....	1	1	1	1
*California cuckoo	4	2	3	3	4	3
*Texas woodpecker	1	1	1	1	1	2
*Chuck-will's-widow	1	1	1	1	1	1
*Black-chinned hummingbird	(1)	(1)	(1)	(1)	(1)	(1)
Crested flycatcher	1	1	1	.....	.....	1
†Ash-throated flycatcher	.....	.....	1	.....	.....	.....
*Wood pewee	5	4	6	5	6	5
*Acadian flycatcher	4	2	4	5	5	3
*Cowbird	(2)	(2)	(2)	(2)	(2)	(2)
*Orchard oriole	5	4	7	5	6	2
*Arkansas goldfinch	10	8	10	8	6	6
*Western lark sparrow	4	4	6	5	3	3
*Chipping sparrow	4	4	6	5	5	5
*Field sparrow	2	4	6	4	2	2
Rock sparrow	1	3	1	.....	.....	.....
*Gray-tailed cardinal	7	9	14	9	5	9
*Western blue grosbeak	2	3	8	6	4	5
*Indigo bunting	4	4	9	7	8	3
Painted bunting	1	2	1	2	.....	1
*Summer tanager	3	3	2	3	4	5
Purple martin	1	2	2	2	.....	.....
*Red-eyed vireo	6	5	8	5	5	5
*Yellow-throated vireo	3	3	3	3	3	4
Black-capped vireo	1	.....	1	1	1	1
*White-eyed vireo	2	2	5	5	4	4
*Black and white warbler	3	3	4	3	2	1
*Parula warbler	1	1	1	2	2	1
*Golden-cheeked warbler	4	3	6	4	4	2
*Kentucky warbler	4	3	6	6	5	4
Chat	2	3	.....	.....	2	3
Mockingbird	1	1	1	.....	1	.....
Canyon wren	1	1	1	1	1	.....
*Carolina wren	6	3	5	5	2	2
*Texas wren	5	3	5	4	2	3
*Sennett titmouse	3	2	7	3	3	4
*Plumbeous chickadee	2	2	4	2	2	2
Blue-gray gnatcatcher	2	1	2	2	.....	.....
Bluebird	.....	.....	.....	.....	1	2
Total number of species	38	39	42	36	34	34
Total number of nesting pairs	110+	103+	159+	127+	106+	101+

*Present every year. †Present only one year. [1] Several. [2] Common.

Concerning the changes in bird life which have taken place in this region during his residence there, Mr. Lacey made the statement recorded in Table 6 in 1914.

As to changes in the bird population, I have lived here since 1882 and do not think that there are fewer birds here now than there were then, but some species are scarcer, and one (the white-necked raven) has left us entirely and gone, I suppose, farther west; it was common here formerly, but the crow has taken its place. The crows came in about 1897, which was the last year that the ravens nested on Turtle Creek.

Bobwhite is much scarcer than he used to be, but is gaining ground again the last year or so. The green heron is another bird that is not so common as it was a few years ago, and purple martins are scarcer than they were, owing possibly to the fact that people won't take the trouble to put up boxes for them on account of the English sparrows taking possession of the boxes as fast as they are put up.

The sparrows came to Kerrville in 1897. The lazuli bunting has nested in the button bushes along our little creek, but I have not seen one for some years. Wild turkeys increased considerably during the last three years, owing probably to very favorable breeding seasons; I am afraid that they will not do so well this year, as we have had many hard rains this spring.

A bird that seems to have left us is Mearns' quail; it was never very common and kept to the rough country, never coming down to the fields as far as I know. Comparatively few quail are shot here, and it is rather hard to see why they should decrease

in number: possibly overstocking the range with cattle, sheep, and goats had something to do with it, and the long drought of a few years ago helped to diminish their numbers. I think it quite possible that they migrated in search of better conditions, and I don't think, as some people here do, that they just died out.

Raton, N. Mex.—A bird census on a tract of 160 acres near Raton, N. Mex., at an altitude of about 6,500 feet, was taken in 1916 and repeated in 1920. This land is prairie, and the nearest timber is 3 miles away. A small creek in which there is water throughout the year crosses the tract, and the crops are all irrigated. In 1916, 12 acres, or 7 per cent of this tract, were under cultivation, and 78 pairs of birds representing 13 species were found breeding. In 1920, with 50 acres, or 31 per cent of the land, in crops, the number of birds was 97 pairs of 12 species. Here the bird life has increased as more land is put under cultivation, while in the more humid sections of the country the reverse is usually the case. Additional food supply due to the raising of more grain may have been the chief factor in this increase in the bird population, since in 1920 there was a colony of 20 pairs of cliff swallows, while in 1916 none of that species was present. This species feeds extensively on the insect enemies of grain and alfalfa that had doubtless multiplied with the increased acreage in these crops.

RELATIVE ABUNDANCE OF CERTAIN SPECIES.

The study of the density of bird life has not been continued long enough, nor have bird counts been made on a sufficiently large scale, to learn definitely the relative abundance and distribution of individual species. To see what could be learned even from the data available, the following 10 widely distributed species of native birds were selected for special study: Bluebird, robin, house wren, brown thrasher, catbird, song sparrow, chipping sparrow, meadowlark, kingbird, and flicker; with these were included the English sparrow and European starling, the latter still being confined to the Northeastern States throughout the period covered by this report. Interesting but by no means final results were obtained, and the returns of another five years may completely overthrow them.

The accompanying table (Table 7), dealing with six of the most abundant species in the Northeastern and North Central States, shows for each, on the basis of the returns, its percentage of the whole number of birds reported, and the average number of breeding pairs per hundred acres. In figuring the number of pairs of birds per 100 acres, the nearest whole number has been used and a plus or minus sign affixed. This table should be studied in conjunction with that showing the character of land on which the counts were made (see Table 1, p. 8), since there is a direct connection between the kind of land, crops, etc., and the species and number of birds breeding.

TABLE 7.—*Relative abundance of the six species reported most abundant on areas surveyed in the Northeastern and North Central States, showing the percentage of the total bird population and the number of nesting pairs per hundred acres.*

Species.	Northeastern States.					
	1916	1917	1918	1919	1920	Average.
Relative abundance:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Robin	10.4	10.8	8.9	4.0	7.3	8.3
Catbird	2.1	2.1	1.5	1.5	1.1	1.7
Song sparrow	6.7	10.8	11.3	3.3	6.4	7.7
Chipping sparrow	5.3	4.1	4.1	2.1	4.2	3.9
Meadowlark	1.8	1.8	0.7	0.4	0.5	1.0
English sparrow	5.4	6.4	4.9	1.7	2.8	4.3
Average population per 100 acres:	*Pairs.*	*Pairs.*	*Pairs.*	*Pairs.*	*Pairs.*	*Pairs.*
Robin	14−	11+	9−	7−	11−	10+
Catbird	3−	2+	2−	3−	2−	2+
Song sparrow	9−	11+	11+	6−	9+	9+
Chipping sparrow	7+	5+	4+	4−	6+	5+
Meadowlark	2+	2−	1−	1−	1−	1+
English sparrow	7+	6+	5−	3−	4+	5

Species.	North Central States.					
	1916	1917	1918	1919	1920	Average.
Relative abundance:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Robin	6.1	6.4	6.7	5.9	5.9	6.2
Catbird	2.8	2.9	1.6	2.8	2.5	2.5
Song sparrow	3.1	3.1	2.4	2.2	3.0	2.8
Chipping sparrow	1.4	1.3	1.9	1.2	1.8	1.5
Meadowlark	4.0	3.4	2.3	6.2	4.3	4.0
English sparrow	7.8	10.1	8.2	6.9	10.5	8.7
Average population per 100 acres:	*Pairs.*	*Pairs.*	*Pairs.*	*Pairs.*	*Pairs.*	*Pairs.*
Robin	8+	8+	10−	8+	7+	8+
Catbird	4−	3+	2+	4−	3+	3+
Song sparrow	4+	4−	4−	3+	4−	3
Chipping sparrow	2−	2−	3−	2−	2+	2
Meadowlark	6+	4+	3+	8+	5+	5+
English sparrow	10+	13−	12+	9+	13−	11+

In the States north of North Carolina and east of the Mississippi River the robin is the most abundant species. Of some 200 reports received from this part of the country during the past five years, only 6 do not record the robin; 4 of these deal with woodland and the other 2 with the same tract of farm land in two successive years. The densest robin population was found at Chevy Chase, Md., where in 1916 31 pairs nested on 23 acres. This was in a residential district in the suburbs of Washington, D. C., where the shade and fruit trees about the houses furnished plenty of convenient nesting sites and an abundant food supply. But on farm land, there were found near Commack, N. Y., in 1916, 30 pairs nesting on 45 acres; at Gettysburg, Pa., in the same year, 31 pairs on 40 acres; near Geneva, N. Y., in 1918, 48 pairs on 92 acres (nearly half of it in orchard); and at Putnam, Conn., in 1920, 29 pairs on 60 acres. Though in the North Central States the robin stands second in point of abundance, when these records are combined with those from the Northeastern States the robin becomes first for the whole region.

The English sparrow occurs in such large numbers about towns and cities, and has there so crowded out the native birds, that it has come to be considered the most abundant species in the country. Happily this is not the case. Essentially a city dweller and finding its most convenient nesting sites in the vicinity of buildings, it has nevertheless spread into the rural districts, and a few pairs are found about the buildings of nearly every farm. Since the counts in most cases have been made on the part of the farm surrounding the buildings, it seems not improbable that the figures include all the English sparrows on the farms where counts were made and consequently furnish a rather high rating for the farming district as a whole. This species seem to be relatively more numerous in the North Central States, the returns giving it first place in that section, while in the Northeastern States it stands third or fourth, being exceeded there by the robin and song sparrow, and one year by the chipping sparrow also. Returns for the Northeastern States show that in 1916 there was 1 pair of English sparrows to 17 pairs of native birds of all species, while in 1920 this proportion dropped to 1 pair of English sparrows to 33 pairs of native birds. For this region and period the record shows an average of two pairs of robins for each pair of English sparrows.

The kingbird has also attracted the interest of the writer. The bird censuses show that though so widely distributed and well known, it is far from abundant. Evidently intolerance of his own kind has been a factor in earning for it the name of tyrant. For the five years, 1916 to 1920, the counts of the birds breeding in the fields and orchards show an average of only 1 pair of kingbirds to 50 acres of such land.

That large series of records are necessary before any conclusive statement can be made regarding the relative abundance of the different species, is shown by the following quotation from the preliminary report of 1914:[4]

> This preliminary census shows that the most abundant bird on the farms of the Northeastern States [here meaning both Northeastern and North Central as considered in the present report] is the robin; that the next is the English sparrow; and that following these are the catbird, the brown thrasher, the house wren, the kingbird, and the bluebird in the order named.

Of the species then enumerated, the catbird is the only native species besides the robin listed in the present report as among the first six, and it falls well down the line.

DENSITY OF BIRD POPULATION.

No particular part of the country seems to have a monopoly on density of bird population. The highest record for any considerable area, 1916 to 1920, inclusive, concerns 40 acres of Golden Gate Park, San Francisco, where 404 pairs of birds representing 36 species were found breeding in 1916, something over 10 pairs of birds per acre.

Next to this in point of abundance of birds is a part of the village of Chevy Chase, Md., where, in 1916, in five blocks containing about 23 acres, there were found nesting 210 pairs of native birds representing 39 species, besides the ubiquitous English sparrow, of which there were 14 pairs. This is a residential district, where birds have been encouraged and protected, and the lawns are planted to shrubbery.

[4] U. S. Dept. Agr. Bull. 187, p. 11.

with shade trees and several large fruit trees. Here the English sparrow is outranked by four native species—the house wren, showing 17 pairs; the purple grackle, 20; the catbird, 21; and the robin, 31; while the 14 pairs of wood thrushes just balance it. In one yard of half an acre the owner found 20 nests belonging to 12 species of birds, the most numerous being 4 of the catbird, which was the densest bird population reported during the period under discussion.

Comparable with the Chevy Chase area is one of 25 acres near the center of the village of Cloverdale, Ala., where 179 pairs of 11 species were found breeding. This again refutes the common belief that the presence of human kind is inimical to a large avian population. The Cloverdale report shows an average of 716 pairs on 100 acres; that at Chevy Chase, 913 pairs. In the former case, however, the gregarious English sparrow formed a much larger proportion of the bird life, the 110 pairs found being over 61 per cent of the total, while at Chevy Chase, where the English sparrow has been somewhat "discouraged," this species forms less than 7 per cent of the nesting population.

The high records for density of bird population above cited are, it will be noted, all on suburban or park land. So far the highest record for land actually farmed concerns 45 acres near Warren, R. I. In 1916 this land had 14 acres in orchard, 20 acres in swamp and brushy pasture, about 1 acre in grove (otherwise no woods for several miles), and the remaining 10 acres surrounding the house and barn, where there are a few large trees, were planted to garden truck. On this tract 163 pairs of birds were found to nest, a rate of 362 pairs to 100 acres. In 1920, 10 acres of orchard had been taken out and the land planted to corn, but the tract still sheltered 154 pairs of birds, or 342 pairs to 100 acres.

This very dense population is explained by supplementary information regarding 65 acres of adjacent territory. About 60 acres of the surrounding land are used for market-gardening, and contain very few, if any, nesting birds. It is, therefore, probable that the birds found nesting on the 45 acres of the count were practically all those on 110 acres. This would make the averages 148 and 140 pairs to the hundred acres, somewhat above the average for New England, but not abnormally high.

BIRD LIFE OF MARSHLAND.

Two series of reports from widely separated localities, each covering the six years, 1914 to 1919, touch upon the problem of the bird life about permanent marsh. Each area contained about 10 acres of marshy land, but the two were so dissimilar in character that they are hardly comparable.

Near Whiting, Ind., D. H. Boyd made counts on a 19-acre tract of land divided as follows: 1 acre of small timber, scrub oak, wild cherry, elm, and poplar; 8 acres of brush, narrow-leaved willow, and sumac; 1 acre of cat-tails; and 9 acres of wild hay and rushes, partially inundated in spring. Bird life here was exceedingly abundant, nearly four and a half times that found to be the average for that part of the country. In the six years the number of species nesting on this tract ranged from 22 to 38, averaging 27, the total species for the period being 55. The number of pairs has varied from 87 to 120, with an average of 107. While the birds nesting on this tract have been fairly constant both in the number of species and pairs, there

has been a great variation in the kinds of birds found each year. Of the 55 species that nested here in the six years, only 10 were present every year, while 21 were present only one year each. Since we have no other series with which to compare this, it is impossible to tell whether this extreme variability is characteristic of marshland or whether it is due to local conditions. (See Table 8.)

TABLE 8.—*Birds nesting on 19 acres near Whiting, Ind., including 10 acres of marshland.*

Species.	1914	1915	1916	1917	1918	1919
Black tern					4	10
†Lesser scaup						1
American bittern	1					1
Least bittern			1	1		
†Green heron		1				
†King rail				1		
Sora			1		4	2
†Florida gallinule			1			
Woodcock	1	1				
*Spotted sandpiper	3	9	4	2	2	2
Killdeer	2	3		1		
Mourning dove		1		1	1	1
†Marsh hawk		1				
†Sparrow hawk	1					
Yellow-billed cuckoo	1	1	1			
Black-billed cuckoo			1	1	2	
†Kingfisher		1				
†Red-headed woodpecker		1				
Northern flicker	2	1	1	1	1	
†Nighthawk	1					
†Ruby-throated hummingbird						1
Kingbird		1			2	1
Crested flycatcher		1	1	1	1	
Wood pewee		2		1		
Least flycatcher		1	3	2	5	3
†Blue jay		1				
Crow		1			1	1
*Bobolink	5	7	6	5	7	6
*Cowbird	3	4	4	7	3	2
*Red-winged blackbird	25	17	21	25	30	25
*Meadowlark	4	3	4	3	3	4
Bronzed grackle	1			1	2	
Goldfinch	2	5	2	1		1
Grasshopper sparrow		2		2		2
Field sparrow		1	1			
*Song sparrow	3	10	11	9	4	8
†Swamp sparrow	5					
†Towhee			1			
†Scarlet tanager		2				
†Barn swallow	10					
*Tree swallow	1	2	3	3	3	3
†Cedar waxwing	1					
†Black and white warbler		1				
*Yellow warbler	10	14	14	11	16	18
†Ovenbird		1				
Maryland yellowthroat		1	2	2	2	3
†Redstart		2				
*Catbird	4	5	7	5	4	5
*Brown thrasher	1	3	2	3	2	2
House wren		3	5	1	1	2
†Short-billed marsh wren			1			
Long-billed marsh wren		1	12	7	8	16
†Hermit thrush		1				
Robin		1	1	1		
English sparrow		2	1	1	1	
Total number of species	22	38	27	27	24	24
Total number of nesting pairs	87	115	112	99	109	120

* Present every year. † Present only one year.

The second series of counts was made by C. J. Pennock on 82 acres about the village of St. Marks, Fla., situated on the St. Marks River, 8 miles from the Gulf of Mexico. A roadway and a railroad track about bisect the area, and along these are 25 buildings, two-thirds of which are dwellings. A few buildings are on the river bank. Only 2 acres

are cultivated, in gardens and a small cornfield. The tract contains three small rain-water ponds without outlets, 6 acres of tidal marsh, and 6 to 8 acres of coarse grass inclined to swamp. About a third of the entire area is covered with timber, mostly pine, with a few cypresses and live oaks near the river. The remainder is open grassland having some scrub palmetto, and most of it used for grazing. At St. Marks the average number of species was 36, with a total of 44, of which 29 were present every year, and there were only 4 species that were found only one year each. (See Table 9.)

A considerable contrast is noticeable between this area and that near Whiting, Ind., in regard to the stability of the species nesting, as will be seen in the accompanying Tables 8 and 9. At Whiting, Ind., the species present every year were 18 per cent of the entire number found and 38 per cent were present only a single year. At St. Marks, Fla., on the other hand, 64 per cent of the species were present every year, while those found only once represented only 9 per cent.

TABLE 9.—*Birds nesting on 82 acres near St. Marks, Fla., including from 12 to 14 acres of marshland.*

Species.	1914	1915	1916	1917	1918	1919
King rail				2	1	1
*Florida clapper rail	1	1	2	1	1	1
†Florida gallinule				2		
†Coot					1	
*Bobwhite	1	2	2	4	2	2
*Mourning dove	2	2	4	3	4	5
*Yellow-billed cuckoo	3	2	4	4	4	5
†Florida screech owl					1	
Southern downy woodpecker		1	1		1	1
*Red-bellied woodpecker	3	2	1	1	2	2
Flicker	1	1				1
*Chuck-will's-widow	2	2	2	2	2	2
*Ruby-throated hummingbird	1	1	2	1	2	1
*Kingbird	3	4	4	4	4	4
*Crested flycatcher	3	2	2	2	2	2
Wood pewee	1	1	1		1	1
*Florida blue jay	6	8	8	6	7	6
Florida crow	1	1				
*Florida redwing	4	4	7	6	6	8
†Southern meadowlark					1	
*Orchard oriole	3	4	5	4	5	5
*Florida grackle	3	5	5	6	8	9
Boat-tailed grackle					2	2
*White-eyed towhee	2	3	1	3	2	1
*Florida cardinal	3	3	5	5	5	5
*Summer tanager	3	3	4	4	2	3
*Purple martin	8	15	10	9	8	8
Rough-winged swallow					1	1
Loggerhead shrike	3	3		2	2	
Yellow-throated vireo	1	1				
*White-eyed vireo	2	2	3	2	2	2
Parula warbler			1	1	1	1
*Yellow-throated warbler	1	2	3	2	2	2
*Pine warbler	3	2	3	3	2	3
*Florida yellowthroat	1	1	2	3	1	2
*Mockingbird	6	13	10	12	10	10
*Brown thrasher	3	2	1	3	4	5
*Carolina wren	4	3	2	2	1	1
*Brown-headed nuthatch	2	2	1	1	1	1
*Tufted titmouse	1	2	1	1	1	1
*Carolina chickadee	2	2	2	2	2	3
*Blue-gray gnatcatcher	4	3	4	3	4	5
Bluebird			2	2	2	2
*English sparrow	7	10	12	10	12	10
Total number of species	34	35	38	34	40	37
Total number of nesting pairs	94	115	117	118	122	124

* Present every year. † Present only one year.

Perhaps the best idea we can get of the bird life of marshland is given by a count made in 1916 on a 56-acre tract near Hinsdale, Ill., containing 15 acres of oats, 10 of pasture, and 31 acres of marsh, about 20 acres being under water all the year. There were a few live willows about the edge and many dead trees in the marsh, and about half the marsh was grown up to flag, cat-tails, and reeds. The 15 species of birds found nesting there were represented by 140 pairs at the rate of 250 pairs per 100 acres, more than double the average for farm land. This bears out the belief that such places are very rich in bird life. The birds found were:

Pied-billed grebe, 1 pair; black tern, 4; blue-winged teal, 1; least bittern, 2; king rail, 1; Virginia rail, 9; American coot, 6; killdeer, 1; mourning dove, 3; bobolink, 2; red-winged blackbird, 68; meadowlark, 7; field sparrow, 11; swamp sparrow, 2; long-billed marsh wren, 22.

BIRD LIFE OF THE WOODLAND.

The forested regions of the country have a much smaller bird population than the open land. The deep woods are places of comparative silence; there seem to be no birds there. Small patches of woodland on the contrary, such as the woodlots of farms, are usually very rich in bird life, especially if the underbrush is not kept cleared. Particularly is this true when the surrounding fields are so much under cultivation as to provide few good nesting sites but an abundance of food. Very few reports of the birds breeding in heavily timbered areas have been received, but those at hand indicate that for each 100 acres of forest there are from 50 to 100 pairs, or an actual average from the reports of about 68 pairs of nesting birds. For the woodlots the bird population is nearly three times this, the reports showing an average of about 182 pairs of birds per 100 acres. This latter accords with the returns for 1914 and 1915, which gave an average of 187 pairs of birds per 100 acres of such land. The present figures for the population of the heavy forest, however, are more than those previously obtained. This is probably accounted for by the fact that some of the counts used in this average were made near the edge of the forest, where birds are more abundant than in the deeper parts.

Three reports have been received which deal with the forests of the Rocky Mountain region. On the east shore of Flathead Lake, Mont., at an altitude of about 3,000 feet, 45 acres of forest contained only 21 pairs of birds in 1916. In the same year 60 pairs were found breeding on a tract of 120 acres near Falcon, Idaho, at an altitude ranging from 4,500 to 5,000 feet. These two areas show approximately the same average of one pair to 2 acres. The same average holds in the southern part of this region, according to the count made in 1920 in the Santa Fe National Forest, previously mentioned. It seems safe to assume, therefore, that 50 to 55 pairs of birds to 100 acres would be the average for the forests of this region and probably also for similar land in the East.

Only one report is on file for a continuous forested area in the East, that made in 1920 by Charles L. Whittle on 562 acres near Peterboro, N. H. This land, situated at an altitude varying from 800 to 1,200 feet, is a part of continuous second-growth timber, the trees being from 20 to 40 years old, predominantly white pine, with

some areas largely birch. In the northwest corner is a small swamp covered with alders. On these 562 acres there were found 502 pairs of nesting birds, representing 52 species, or at the rate of 89 pairs per 100 acres. This is 78 per cent greater than the bird population found in the Rocky Mountain forests, but is probably explained by the difference in the kind of land surveyed rather than in the number of birds per acre in the eastern and western forests. In this case part of the woods was adjacent to open land, so that birds would naturally have been more abundant than in the deeper forest.

This wooded area surrounds a tract of 78 acres of cleared land, which was also surveyed. The latter tract contained 48 acres in grass and other farm crops, with about 50 old apple trees scattered over it, and 1 full acre of dwarf orchard. In one corner was a swamp of about one-eighth of an acre, drained by a wet-weather stream. Efforts had been made to attract birds by the placing of bird baths, a 16-compartment martin house, and a dozen bird boxes. On this land there were 162 pairs of birds representing 23 species, a rate of about 208 pairs per 100 acres.

Regarding these two areas Mr. Whittle says:

> It appeared to us that this sharply defined relationship of forested land, surrounding closely and nearly solidly an unforested tract, afforded an excellent opportunity to compare the nesting bird life of each area, and, while the area selected is somewhat ambitious as to size, I can assure you that it has been combed by systematically spaced swaths (cruised east and west), and the lists submitted perhaps contain no more errors than appertain to the nature of the work. * * *
>
> The most abundant family was warblers, of which there were 11 genera and 262 [pairs of] birds, or 39.45+ per cent of the total number of all birds found. To this family also must be credited the largest number of any single species; 66 oven-birds were found, constituting only a fraction under 10 per cent of the total birds. The robin was next in abundance, comprising 9+ per cent of the total.
>
> The robins' nests in the larger area were confined to the immediate inner border next the open fields. None nested in the deep shade of the thick pine forest, especially where the trees are large.

SCARCITY OF BIRDS IN 1918.

A decrease in the number of breeding birds per acre in 1918 was noted in many cases when tabulating the results of the bird counts for the five years 1916–1920, and a close study was made of the subject in order to ascertain whether this decrease was real or only apparent, local or general, and, if possible, its cause. For the part of the country lying east of the one hundredth meridian there are on file 24 series of reports covering the same tracts of land for at least the three years 1916–1918. These reports cover a total of 1,478 acres and represent areas picked at random in 18 States, from Maine to Florida and from Minnesota to Texas, and may be considered to reflect fairly well the conditions in the eastern United States.

Examination of these reports reveals that in 1918 73 species show a decrease on two or more reports and 28 more on one report each. Ten of the species show a decrease on four reports and 22 on five or more, the highest being the catbird on 11 reports and the phoebe and song sparrow on 9. The following list will give some idea of the species affected: Mourning dove, 2 cuckoos, 7 species of woodpeckers, nighthawk, chimney swift, 2 species of hummingbirds, 8 species of flycatchers, meadowlark, 2 orioles, 19 species of sparrows, 2 tanagers, 3 species of swallows, 6 species of vireos, 13

species of warblers, mockingbird, catbird, brown thrasher, 4 species of wrens, and 5 species of thrushes. It will be noted that a large number of these birds are insectivorous and that comparatively few of them winter within the United States.

The numerical decreases of some species on the above-mentioned reports may be of interest. The figures given in Table 10 seem small, but when it is considered that the total acreage to which they apply is only an infinitesimal part of the whole area presented, they become significant.

TABLE 10.—*Species of birds that in 1918 showed a marked decrease in numbers.*

Species.	Number of reports.	Decrease in pairs.	Species.	Number of reports.	Decrease in pairs.
Mourning dove	6	11	Scarlet tanager	5	10
Flicker	8	11	Red-eyed vireo	8	11
Phoebe	9	13	Maryland yellowthroat	6	8
Wood pewee	7	17	Catbird	11	14
Meadowlark	7	11	Brown thrasher	6	8
Baltimore oriole	6	7	House wren	7	9
Song sparrow	9	30	Robin	8	18

The greatest decrease in the total number of breeding pairs on a given area was 46⅔ per cent on 40 acres at Florence, Ala., and two other tracts showed decreases of over 40 per cent each.

Examination of the reports shows that of the total land surveyed only 6 acres more were plowed than in the preceding year, thus eliminating the possibility that more intensive cultivation had caused the birds to nest elsewhere. Neither could severe weather conditions during the previous winter have affected those species that winter south of the United States.

E. H. Forbush, State ornithologist of Massachusetts, made an extensive investigation in 1917 of the effect on insectivorous birds of the cold and rainy weather of May and June of that year. He found that during that time thousands of birds perished from lack of food, due to the weather conditions. Concerning this destruction of bird life by the elements, he says in part:[5]

* * * The weather report asserts that the low temperature and lack of sunshine retarded vegetation, so that the season at the close of May was from three to four weeks later than normal.

* * * It was not until the middle of June that the wild flowers appeared as they ordinarily do in the latter part of May. There was a similar delay in the appearance of insects. Eggs of insects failed to hatch at their usual time, but apparently the cold weather did not destroy them. With the exception of tent caterpillars and a few others, insects appeared in their full, normal numbers later in the season. A few birds appeared earlier than normally, but the main flight of insect-eating birds came a week or ten days later than usual. Even then the birds came too soon, for their insect food was not ready for them. Many of the early swallows and martins apparently succumbed to the cold storms which came after the birds arrived. Several observers report finding dead martins and swallows in nesting boxes. * * *

* * * In going over the reports from various correspondents the first fact almost universally observed was that of an unusual flight of birds, particularly insect-eating species, such as warblers. Only a very few observers had not noticed this. The next fact noted was that the birds were much less shy than usual, and that they were seen more about houses, in villages and closer to the ground than in ordinary seasons. The warblers were so weak and so preoccupied in seeking food that many of them could almost be taken by hand, and as they grew weaker some were so caught.

[5] Forbush, E. H., Tenth Annual Report of the State Ornithologist, pp. 14-22, Boston, Mass., 1917.

* * * This destruction of insect-eating birds over a large part of the State is a serious matter in itself, but evidently similar conditions were maintained over a much larger area through northern New England to New Brunswick, at least as far south as Pennsylvania and as far west as Michigan. A few reports from other parts of the country indicate that the decimation of birds in many other regions was quite as serious as in Massachusetts.

* * * No one can tell how far the destruction of bird life extended, but a glance at the weather map seems to indicate that conditions more or less similar to those in New England during May existed nearly all the way across the continent.

* * * Nothing has been heard of any bird catastrophe in the South, and little is known about the effect of the backward spring in Canada, where it may have been very destructive to bird life. The great catastrophe, then, seems to have been confined mainly to a large part of a tract about 1,000 miles in width, extending from Pennsylvania and Michigan north into Canada; but just how far, no one knows.

Because of the stormy weather and the backward season, comparatively few young birds were raised that year. Cold prevented the hatching of many eggs, and lack of foliage left the eggs and young exposed not only to storms but to their natural enemies. Jays and crows, unable to secure insects, turned to the eggs and young of the smaller birds for food. Heavy rains caused floods, in places doubtless drowning out birds that nest in low bushes or on the ground.

It is the generally accepted belief that under normal conditions the young birds of one season about equal the number killed from all causes before the young of the next season are on the wing. It becomes evident, therefore, that following such an unfavorable breeding season as that of 1917, the birds affected would return to their breeding grounds the next year in greatly depleted numbers.

The birds that survived the migrations to and from their winter home again encountered unfavorable conditions when they reached the United States in the spring of 1918. Migration tables indicate that these birds should have arrived in the United States from the middle of March to the latter part of April. According to weather reports for 1918, February and March throughout the Gulf States were warm and dry, but April, except the first few days, was unusually cold and rainy, with excessive precipitation in some places. On the 12th a killing frost extended as far south as northern Florida. Such conditions doubtless further decimated the numbers of migrant birds.

In the case of those species that winter in the United States, the unusually deep snows of the previous winter might well be considered the principal cause of their scarcity during that summer. It is known that in the vicinity of Washington, D. C., Carolina wrens became very scarce after a heavy snowfall early in February, and there seems good evidence that they perished rather than migrated, since they did not return with the warm weather but continued to be scarce for at least two years. After the storm, they were seen searching in unusual places, indicating that food was difficult to find. The same thing has been noted elsewhere in different years with regard to this and other species.

That this scarcity of birds in 1918 extended into Canada is indicated by a series of reports from Manitoba. Two tracts with a total of 102 acres, on which counts have been made since 1914, showed in 1918 a decrease in 13 species elsewhere noted as scarcer that year; and a total decrease was noted of 20 pairs, or slightly over 13 per cent.

Wherever the data over a given tract continue for 1919 and 1920, they indicate a gradual return to the normal numbers of breeding birds. In some cases, in 1920, the total number of birds nesting was greater than in any previous year recorded.

One of the largest continuous areas on which a census has been taken is 210 acres at Rhinebeck, N. Y., a part of Grasmere Farms, and M. S. Crosby explains that in making the count he divides the tract into five sections, going over each several times during the breeding season. This tract contains 92 acres of woods, creek, and swampy land, 40 acres of orchard, 58 acres plowed for crops, 5 acres of pasture, and the remaining 15 acres in drives, lawns, gardens, and buildings. All birds except starlings and English sparrows are strictly protected and the latter are kept down to 15 to 20 pairs. For the years 1915–1917 the bird life here was fairly constant and averaged 369 pairs and 55 species, a rate of 176 pairs per 100 acres. No count could be made in 1918 or 1919, and when the count in 1920 showed only 254 pairs of 47 species nesting within the area, Mr. Crosby expressed himself as much puzzled and totally unable to account for the great decrease and even total disappearance of certain species formerly common. This decrease now seems to be satisfactorily explained and it is a matter of regret that the minimum figures are not available.

Evidently the loss in bird life here in 1918 was very great or else something in local conditions retarded the recovery, since in 1920, the second season after, the number of birds breeding was still 30 per cent below that of 1917. It is possible that this indicates very nearly the minimum, for areas on which there are continuous reports show little or no increase in 1919, though in most places the increase had become considerable by 1920.

BIRDS RESPOND TO PROTECTION.

Birds are too few on the farms, especially about the parts more intensively cultivated, and should be encouraged in every way.[6] Protection alone will help a good deal, as shown by the increase in bird life at Viresco, Va., already noted; but at the same time shelter and nesting sites must be provided, or, at least, not destroyed. Clearing the brush from woods and along fences and roadsides destroys the nest sites of many birds, driving them away from fields where their assistance is needed. Efforts toward attracting birds should not be limited to the area immediately surrounding the house, but should be extended to the part of the farm that is under cultivation. Most nesting birds subsist largely on insects, and young birds are fed almost exclusively on them.

The response of birds to protection and friendly care is shown by a report from near Pontiac, Mich. Here a tract of 150 acres has been posted for several years and the birds thereon carefully protected; dogs have not been allowed to run wild, all vermin have been shot on sight, and English sparrows have been kept down by shooting and trapping. Over fifty bird houses have been erected, including

[6] Farmers' bulletins of the United States Department of Agriculture on methods of attracting birds are as follows: No. 609, Bird Houses and How to Build Them; No. 621, How to Attract Birds in Northeastern United States; No. 760, How to Attract Birds in Northwestern United States; No. 844, How to Attract Birds in the Middle Atlantic States; No. 912, How to Attract Birds in the [illegible] States; No. [illegible]. Community Bird Refuges.

a 22-room martin house, and regular feeding stations are maintained during about eight months of the year.

A bird census taken on 60 acres of this land in 1920 shows that the birds have not been slow to recognize the advantages of this area as a nesting place, but no data are available for comparison to show what changes have taken place since the land has been protected. This section contains the house with flower garden and lawn, about 20 acres of woods including hardwoods and tamarack, 3½ acres of plowed land, and the remainder in grass, with scattered shrubs, mostly juniper. The land is hilly, the higher and more heavily wooded part to the north and west, and sloping to the south, where a small lake extends into the tract for about 2 acres. There are three small ponds and a creek flowing into the lake, the shores of which are marshy, the trees in some places coming nearly to the water.

Here the birds find food, water, plenty of shelter, and protection from their enemies, natural as well as human, and they have responded by nesting about three times as closely as the normal average. The birds found breeding were as follows:

Woodcock, 1; mourning dove, 6; red-tailed hawk, 1; black-billed cuckoo, 3; red-headed woodpecker, 4; flicker, 2; whippoorwill, 2; ruby-throated hummingbird, 1; kingbird, 1; crested flycatcher, 2; phoebe, 2; wood pewee, 6; blue jay, 3; crow, 3; cowbird, 10; red-winged blackbird, 5; Baltimore oriole, 4; goldfinch, 7; chipping sparrow, 7; field sparrow, 15; song sparrow, 11; towhee, 8; indigo bunting, 5; scarlet tanager, 2; purple martin, 10; bank swallow, 2; cedar waxwing, 2; red-eyed vireo, 5; yellow-throated vireo, 1; yellow warbler, 15; cerulean warbler, 1; ovenbird, 3; Maryland yellowthroat, 4; catbird, 12; brown thrasher, 1; house wren, 12; white-breasted nuthatch, 1; blue-gray gnatcatcher, 4; wood thrush, 2; robin, 10; bluebird, 7; English pheasant, 1; English sparrow, 10; a total of 214 pairs of 43 species.

At Silver Spring, Md., in 1917, the birds gave evidence of their appreciation of efforts in their behalf. The owner of a 6-acre tract has left the place wild for the sake of the birds. About half of this land is hilly meadow, considerably overgrown with bushes and young locust, and the rest is divided about equally between tangled woodland, garden, and grove around the house. Additional attractions have been supplied in the form of feeding stand, bird bath, and several nest boxes. The birds that responded to this care in 1917 were:

Bobwhite, 1; red-headed woodpecker, 1; whippoorwill, 1; kingbird, 1; phoebe, 1; wood pewee, 1; starling, 1 (the second record of the breeding of this species in the vicinity of Washington); orchard oriole, 1; field sparrow, 1; song sparrow, 2; chewink, 2; cardinal, 1; indigo bunting, 2; red-eyed vireo, 2; Maryland yellowthroat, 2; yellow-breasted chat, 1; redstart, 1; catbird, 4; brown thrasher, 1; house wren, 7; robin, 2; bluebird, 2; a total of 38 pairs of 22 species.

Several instances of the abundance of birds on protected areas have already been mentioned. Others may be cited. An average of four years' records at Savannah, Ga., shows 30 pairs of 22 species nesting on 12 acres, about half of which is woodland. At Collins, N. Y., a tract of 28 acres, about equally divided between woods and open land, is protected, but no extra attractions are furnished for the birds. Nevertheless, seven years' counts show the average of 33 species and 72 nesting pairs of native birds. At Ewing, Ill., 5 acres, of which 2 were orchard and 1 garden, for four years have averaged a population of 22 pairs of 13 species of native birds besides 4 pairs of English sparrows. At Putnam, Conn., on 60 acres, of

which 1½ are in orchard, 4 to 5 in crops, and none in woods, there was an average population for four years of 32 species and 121 pairs of native birds and 2 pairs of English sparrows.

SUMMARY.

Results of bird censuses for the five years 1916 to 1920, inclusive, show a very close agreement with those obtained in 1914 and 1915 for the section of the country lying north of Maryland and the Ohio River and east of the Great Plains—a little more than one pair of birds to the acre as the average for farm land. For the land immediately surrounding the buildings and including the lawns and orchard, on the average about 130 pairs of birds are found to nest on 100 acres; the estimated bird population of the entire farm is about 112 pairs to 100 acres.

The counts made in the southeastern section of the country have been on tracts so scattered and of so small an acreage that no conclusions concerning the average bird population are yet possible. The same is true of counts on the Plains, where, except for a few species, birds are largely confined to river bottoms and planted groves. In the Rocky Mountain region and westward, the country is even more diversified, and the added problem of altitude makes general averages practically impossible, even with many times the data now at hand.

The robin is the most abundant species in the States north of North Carolina and east of the Mississippi, and the English sparrow is second. For the farm land in this section, as represented by the counts, there are approximately 9 pairs of robins and 8 pairs of English sparrows to 100 acres.

No general statement of the average bird population of marsh areas is at present possible. The marshes are the home of several colony-nesting species, and the population per acre is, therefore, usually much greater than on farm land.

In small patches of woodland, especially when they are surrounded by cultivated fields, birds nest very abundantly, but in the deeper woods they are scarce. For the former, the average bird population is 182 pairs to 100 acres; but the estimate given of 68 pairs to 100 acres of the latter is probably rather high. Several counts made in the forests of the Rocky Mountain region show about one pair of birds breeding on two acres, and it is probable that the same proportion holds in similar regions in the Eastern States.

The counts of 1918 showed birds to be much less abundant than in other years covered. Unfavorable weather conditions during May and June of the year preceding took heavy toll of the insectivorous birds throughout the States east of the one hundredth meridian, and unusual storms in the Southern States during the winter and spring which followed proved hard on birds wintering there. By 1920 much of the loss had been regained.

Birds respond to protection, and on areas where they are protected they nest much more abundantly than on surrounding territory.

FUTURE WORK.

The bird census work must be carried on through many years and on a much larger scale if exact data are to be accumulated on which to base definite comparisons for determining what changes are taking place in the bird life of the country and whether these changes are local or general. The data now at hand indicate that on a given area where birds are protected the number breeding will gradually increase from year to year; but how long this will continue and what will occur when the maximum density is reached can not yet be determined. Previous to the destructive season of 1917, the results of which were so apparent in the censuses of 1918, there had been a gradual increase in the number of birds per acre on many tracts in the eastern United States, and following this setback birds are found to be again on the increase.

Long series of exact records, such as this work will provide, will indicate whether the birds in the country as a whole or in certain localities are increasing or decreasing; or whether following periods of increase, setbacks such as the unfavorable season of 1917 tend to keep the average over a period of years approximately the same. From the work thus far done, it seems that over a long period changes may be expected in the distribution and relative abundance of certain species, rather than in the total number of birds in the country. On some tracts, little change in the number of birds is apparent from year to year, while on others an increase is shown, and on still others a decrease. Are such changes due to local conditions or are they part of definite changes that are taking place in the bird life of the country?

With bird censuses continued year after year, a large amount of increasingly valuable data will be accumulated, from which much can be learned regarding the bird life of the country and the changes that take place. Each year's records add to the value and usefulness of those already on file. Many problems are presented by the material now in hand and new problems are brought out by each year's work, for the solution of which we must look to the future.

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